PRIKAZ LABORATORIJE ZA MODELSKA DINAMIČKA ISPITIVANJA INOVACIONOG CENTRA ZA ZEMLJOTRESNO INŽENJERSTVO SISTEMA DC 90

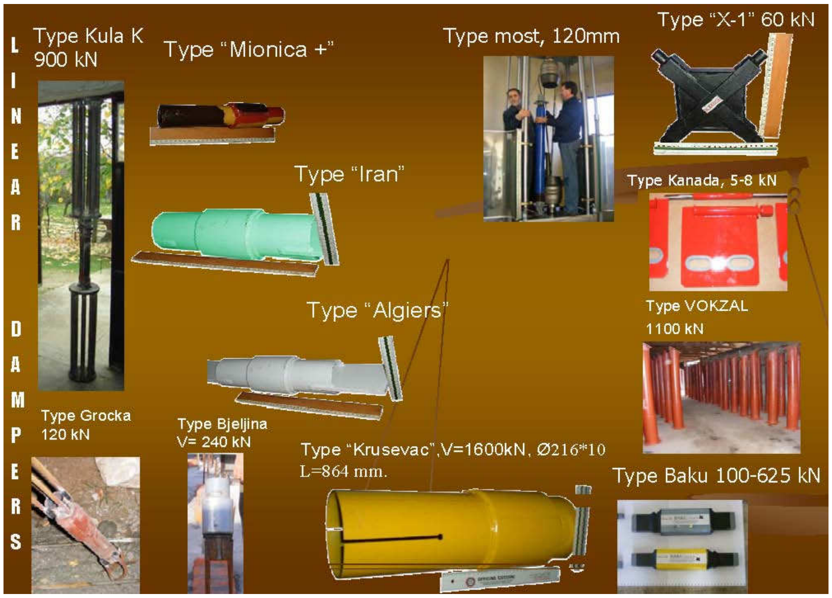
PRESENTATION OF THE LABORATORY FOR MODEL DYNAMIC TESTING IN THE EARTHQUAKE INGENEERING INNOVATION CENTRE OF SYSTEM DC 90

Uvođenju novog rešenja prigušivanja udara seizmičkog opterećenja u praktičnu primenu prethodio je koncepcijski razvoj, zasnovan na niskocikličnom zamoru i plastičnoj deformaciji čeličnih dampera, kao i projektovanje i konstruisanje sistema na objektu koji se štiti ili sanira posle oštećenja. Najznačajnija komponenta u sistemu je damper, kako u pogledu projektnog rešenja tako i u pogledu dokaza o njegovoj funkcionalnosti /1-3/. To zahteva obimna ispitivanja, koja treba osmisliti i izvesti.

U početnoj fazi razvoja dampera, kao i u toku usavršavanja konstrukcija dragocena je bila saradnja Sistema DC 90 sa Institutom za seizmičko inženjerstvo i inženjersku seizmologiju (IZIIS), Skoplje, Makedonija, sa Vojnotehničkim institutom (VTI), Beograd, Institutom za ispitivanje materijala (IMS), Beograd, Univerzitetom u Ljubljani, Fakultet za građevinarstvo i geodeziju, Ljubljana, Slovenija, i Nacionalnim centrom za primenjena istraživanja u zemljotresnom inženjerstvu, Alžir, i ispitivanja, izvedena u saradnji sa stručnjacim iz tih institucija. Koliko je problema prisutno može se zaključiti iz asortimana razvijenih tipova dampera (sl. 1).

Introduction of new solution for damping of seismic loading shocks in practical application foregone by the conceptional development, based on steel damper low cycle fatigue and plastic deformation, as well as design and construction of system on the object to be protected or retrofit after damage. The most important component in a system is damper, both regarding design solutin and proof about its functionality./1-3/. This imposes extended testing, which should be imagined and performed.

In an early stage of damper development, and during design improvement valuable collaboration has been established between System DC 90 and the Institute of Seismic Engineering and Engineering Seismology (IZIIS), Skopje, Macedonia, Military Technical Institute (VTI), Belgrade, Institute for Materials Testing (IMS), Belgrade, Univerity of Ljubljana, Faculty of Civil and Geodetic Engineering, Ljubljana, Slovenia, and The National Center of Applied Research in Earthquake Engineering (CGS), Algeria, and testing performed jointly with the experts from these institutions. It is possible to gess from developed damper types assortiments how many problems can be met (Fig. 1).



Slika 1. Asortiman razvijenih dampera Sistema DC 90

Figure 1. Assortiment of developed dampers in System DC 90

Za dalja ispitivanja inovacija u pogledu uticaja zemljotresa bilo je potrebno razviti specijalnu opremu. Pre svega je na osnovu stečenog iskustva definisan projektni zadatak, a u narednoj fazi je uključen veliki broj saradničkih institucija i stručnjaka potreban za ostvarenje ovakvog uređaja. Tako je razvijen koncept i izrađen jedinstveni hidraulički sistem zatvorene petlje za modelska dinamička ispitivanja i ispitivanja velikim promenljivim opterećenjima dampera i modela objekata.

For next testing of innovations regarding earthquake effects new special equipemnt was necessary. First of all, project requirements are defined based on gathered experiance, and in next phase great number of cooperative institutions and experts is involved, necessary for the acomplishment of such device. In this way the concept is developed and unic hydraulic clossed-loop system constructed for model dynamic testing and testing by high variable loadings of dampers and object models.

Autor koncepta je Zoran Petrašković, saradnik firme Sistem DC 90, Beograd, uz konsultaciju prof. Ljubomir Taškov i prof. Lidija Krstevska, saradnika IZIIS. Razrada projekta je poverena Žarku Petraškoviću. Izradu delova, proizvodnju komponenti i sklopova, kao i montažu sistema vodio je Slobodan Radivojević, saradnik preduzeća Radijus Mionica. Hidraulični cilindri su isporučeni prema posebnoj specifikaciji od strane preduzeća Prva petoljetka, Trstenik. S obzirom na uslove i mogućnosti, ugrađena je oprema dostupna na tržištu kada je to bilo moguće, a razvoj specifičnih uređaja je delo domaćih eksperata, shodno postavljenom projektnom zadatku. Servo ventil američke firme MTS nabavljen preko Italije, a firma AFS, Beograd, i njeni stručnjaci, Dragan Nauparac i Zoran Nikolić su obezbedili hidrauličnu opremu. Softver za upravljanje sistemom je projekt Mikana Radivojevića. Senzori za merenje pomeranja i merenje ubrzanja sa komponentama nabavljenim u SAD su obezbeđeni preko Josifa Jordanovskog, saradnika firme M3E-EKA, Makedonija. Sistem za stalni nadzor (oskultaciju) je razvijen uz pomoć Tina Mihajlovika i Saša Atanasovskog, saradnika iz Makedonije firme Digitexx, SAD.

Izgled kidalice tokom postavljanja i završne montaže je prikazan na sl. 2.

The author of the concept is Zoran Petrašković, company System DC 90, Belgrade, with Prof. Ljubomir Taškov and Prof. Lidija Krstevska, IZIIS coworkers serving as consultants. Project elaboration was confined to Žarko Petrašković. Elements manufacturing, production of components and assemblies, and final assembling had been managed by Slobodan Radivojević, company Radijus Mionica. Hydraulic cylinders were delivered by company Prva petoljetka, Trstenik, following special specification. Obeying the conditions and opportunities, the assessories available on the market were built-in when possible, and the development of specific devices was the task of domestic experts,. based on specified poject requirements. Servo valve of american company MTS was supplied via Italy, and AFS, Beograd, and its experts, Dragan Nauparac and Zoran Nikolić supplied hidraulic devices. Software for system control as a project of Mikan Radivojević. Sensors for displacement and acceleration measurement with component procured from USA were assured by Josif Jordanovski, company M3E-EKA, Macedonia. Tino Mihajlovik and Sašo Atanasovski, coworkers from Macedonia of the company firme Digitexx, USA, helped the development of oscultation system.

The view of testing machine during erection and final assembling is presented in Fig. 2.

Slika 2. Hidraulična kidalica sa zatvorenom petljom: aksijalna promenljiva sila do ± 5000 kN i pomeranje do ± 265 mm, sa vertikalnim okvirom za gabarite do 5000x3000x1000 mm, postavljena na otvorenom

Figure 2. Hydraulic closed loop testing machine: axial variable force to ± 5000 kN and displacements up to ± 265 mm, with a vertical frame for 5000x3000x1000 mm, outdore located

Postavljanje kidalice – Erection of testing machine

Završna montaža – Final assembling

Izveden i pušten u pogon hidraulični sistem sa bitnim elementima savremenog rukovanja se može koristiti za ispitivanja u pet dizpozicija.

1) To je vibro-platforma dimenzija 800x2400 mm za modele mase do 1 tone i za dinamičko opterećenje u proizvoljnom vremenskom zapisu frekvencije do 15 Hz, pri pomeranjima ± 30 mm.

Produced and put into operation hydraulic system with substantial elements of up-dated control can be applied in five dispositions.

1) This is vibrating platform, sized 800x2400 mm, for the model of mass up to 1 ton and dynamic loading in optimal time record in the frequency up to 15 Hz, at the displacements ± 30 mm.

2) Aksijalno dinamičko ispitivanje promenljivim opterećenjem pritisak - zatezanje u ramu elemenata dužine do 2000 mm silama do ± 20 kN uz frekvenciju do 15 Hz i pomeranja ± 30 mm.

3) Ispitivanje modela u vertikalnom ramu gabarita 3000x2500 mm aktuatorom za horizontalna dinamička dejstva navedenih dinamičkih karakteristika.

4) Ispitivanje na vertikalna dinamička opterećenja linijskih konstrukcija gabarita 600x2000x3000 mm aktuatorom navedenih dinamičkih karakteristika.

5) Kvazidinamičko ispitivanje elemenata konstrukcije gabarita 5000x3000x1000 mm promenljivim opterećenjem pritisak - zatezanje u vertikalnom ramu maksimalnom silom ± 5000 kN, uz pomeranja do ± 265 mm.

Tokom svečanog puštanja hidrauličnog sistema u pogon demonstrirane su neke mogućnosti primene, ovde ilustrovane sl. 3 – 5.

2) Uniaxial dynamic testing by variable loading in tension – compression in the frame of elements in length up to 2000 mm by forces to ± 20 kN at the frequency to 15 Hz and displacements ± 30 mm.

3) Model tresting in vertical frame sized 3000x2500 mm using the actuators for horizontal dynamic loading of specified dynamic characteristics.

4) Testing by vertical dynamic loading of linear structures sized 600x2000x3000 mm using actuators of specified dynamic characteristics.

5) Quasi-dynamic testing of structural components in size 5000x3000x1000 mm by variable loading in tension – compression by maxumal force of ± 5000 kN, and displacements up to ± 265 mm, applying a vertical frame.

During ceremonial inauguration of the hydraulic system some of possible applications had been demonstrated, here illustrated by Figs. 3 – 5..

Slika 3. Ispitivanje dampera tipa Vokzal na kidalici 5000 kN

Figure 3. Testing of damper tipe Vokzal on the testing machine 5000 kN

Slika 4. Hidraulična kidalica sa zatvorenom petljom: aksijalna promenljiva sila do ± 20 kN i pomeranje do ± 30 mm, ispitni uzorci dužine do 2000 mm, uz frekvenciju do 15 Hz, kombinovana sa vibroplatformom 800x2400 mm za modele mase do 1 tone

Figure 4. Hydraulic closed loop testing machine: axial variable force to ± 20 kN and displacements up to ± 30 mm, testing samples to 2000 mm in length, at frequency to 15 Nz, combine with vibrating platform 800x2400 mm for models of 1 ton mass

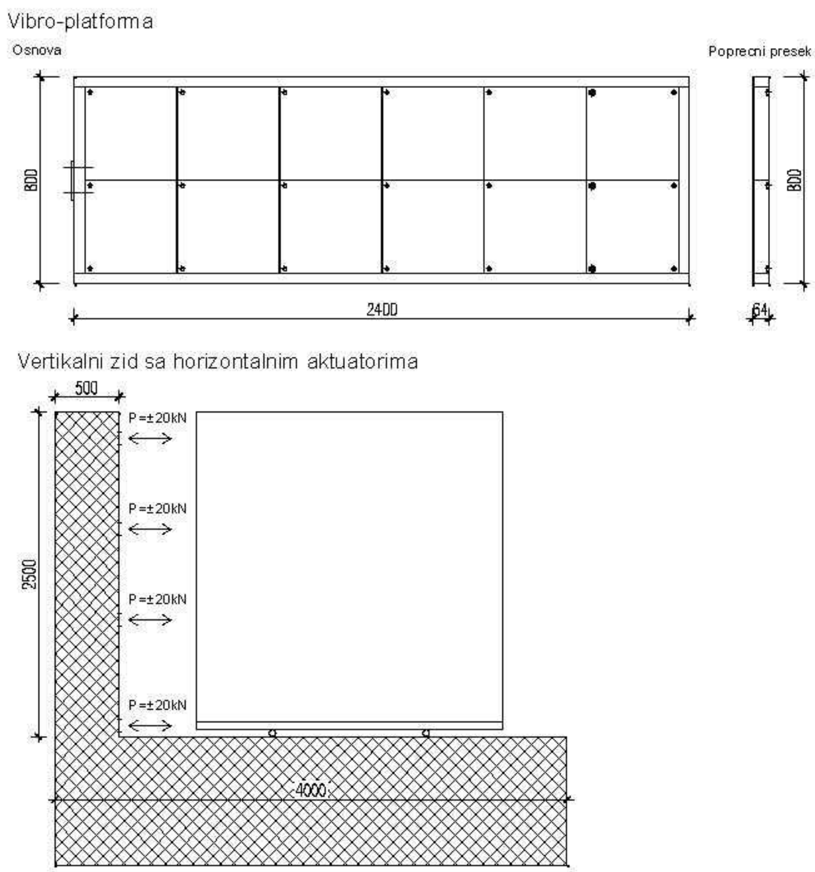
Izgled sistema - View of the system

Pult za kompjutersko upravljanje - Computerised control desk

Neke od navedenih dispozicija su zahtevale dodatna rešenja. Tako je za vibroplatformu bilo potreno posebno projektovati vertikalni zid (sl. 6), na koji su postavljeni horizontalni aktuatori ± 20 kN.

Some of presented dispositions required additional solutions. It was necessary to design special vertical wall (Fig. 6), on which horizontal actuators of ± 20 kN could be positioned..

	
Slika 5. Vibroplatforma – Figure 5. Vibrating platform	
Opšti izgled – General view	Ispitivanje modela – Testing of models



Slika 6. Shema konstrukcije temelja vibroplatforme

Figure 6. Sheme of vibrating platform foundation design

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